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A contribution to the nonlinear control of floating wind turbines

Résumé

Floating wind turbines allow the use of the abundant wind resource in ocean area and are considered as a promising solution of renewable energy. However, due to the additional dynamics (especially the platform pitch motion) introduced by the floating platform, the control of a floating wind turbine must take such pitch motion into consideration to stabilize the system meanwhile optimizing the power output.

This work is dedicated to the nonlinear control of floating wind turbines in region III, this class of controllers requiring reduced knowledge of system modeling and parameter. The control objectives are to maintain the power output at its rated value, to reduce the platform pitch motion and to limit the fatigue load. Firstly, a simplified adaptive super-twisting is proposed. Then, by using collective blade pitch control, this algorithm and other adaptive high order sliding model algorithms are applied on a nonlinear floating wind turbine model. Secondly, a permanent magnet synchronous generator is supposed to be installed in the floating wind turbine. Both collective blade pitch control and generator torque control based on adaptive high-order sliding mode control are used to achieve the control objectives. Thirdly, individual blade pitch control combined with collective blade pitch control is employed. Such algorithm further reduces the fatigue load of blades. Finally, the proposed simplified adaptive super-twisting algorithm is validated on an experimental floating wind turbine set-up (with a spar-buoy platform) in a wave tank, and the control performances are evaluated versus linear control approaches such as gain-scheduled PI and linear–quadratic regulator.

Mots-clés : floating wind turbine, adaptive control, high-order sliding mode, blade pitch control